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EXAMINER
BAUMEISTER, B

ART UNIT	PAPER NUMBER
2815	

DATE MAILED: 10/03/01

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

Office Action Summary

Application No.
09/461,756

Applicant(s)
Kano

Examiner
William Baumeister

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on Jul 18, 2001
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-31 is/are pending in the application.
- 4a) Of the above, claim(s) 5, 6, 9, 12, 19, and 22-31 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-4, 7, 8, 10, 11, 13-18, 20, and 21 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claims _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are objected to by the Examiner.
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

- 13) ☒ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).
- a) ☒ All b) ☐ Some* c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

*See the attached detailed Office action for a list of the certified copies not received.

- 14) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

- 15) ☒ Notice of References Cited (PTO-892) 18) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 16) ☒ Notice of Draftsperson's Patent Drawing Review (PTO-948) 19) ☐ Notice of Informal Patent Application (PTO-152)
- 17) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s). 4, 5, 6 20) ☐ Other:

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DETAILED ACTION

Election/Restriction

1. Applicant's election with traverse of Species IA in Paper No. 8 is acknowledged. The traversal is on the ground(s) that the restriction has not established that an undue burden would result from examining all of the claims. This is not found persuasive because the various species possess mutually exclusive characteristics as explained in the restriction requirement, each of which requiring further consideration and search not required for the other species.

The requirement is still deemed proper and is therefore made FINAL.

Claim Objections

2. Claims 7 and 8 are objected to because of the following informalities: "bandwidth" should be changed to "bandgap." Appropriate correction is required.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

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4. Claims 1-4, 7, 8, 10, 11, 17, 18, 20 and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tsuji et al. '068 in view of Takagi et al., "Design of Multi-Quantum Barrier (MQB) and Experimental Verification of MQB Effect." Tsuji discloses p-i-n light-receiving or photoelectric devices wherein a series of superlattice structures are separated by well layers (carrier accumulation layers) which are composed of the same material (having the same band gap) as the wells of the superlattice (see e.g., FIGs 10-12, col. 3, line 30 and col. 8, lines 14-25). The barrier and wells layers of the superlattice regions are dimensioned so as to cause reflection above the conventional or expected conduction energy band level, creating a virtual barrier thereabove. Tsuji makes reference to earlier works of Capasso (e.g., col. 2, lines 1-) but does not expressly set forth the theory or calculations employed to set the thicknesses of the wells and barriers so as to produce this virtual barrier in the superlattice regions.

a. Takagi teaches that a virtual barrier above the expected energy level of the barrier's conduction band may be produced by setting the thicknesses of the superlattices' barriers and wells to odd multiples of a quarter-wavelength of carriers that are to traverse the superlattice. The equations for setting these thicknesses are exactly the same as the equation set forth in claim 3 except that Takagi teaches odd-multiples instead of even multiples as set forth in the present claims ($n = \text{even integer}$). (Mathematical calculations showing the relationship in terms of the layers' thicknesses have previously been included in other of Applicant's applications, including US Pat #6,188,083.) It would have been obvious to one of ordinary skill in the art at the time of the invention to set the superlattice barrier and well layers of Tsuji to odd multiples of a desired

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carrier wavelength according to Takagi for the purpose of improving the carrier reflectivity above the barrier conduction at these wavelengths as taught by Tsuji and Takagi.

b. The preceding explains why motivation exists to combine the references based on producing thicknesses that are odd multiples of a quarter wavelength of an energy, but does not address the limitation of the present claims that the thicknesses be even multiples. Nonetheless, once the teachings of these references are combined in the manner and for the reasons set forth above, the resultant structure will inherently satisfy all of the limitations of the stated claims, including the limitation that the thicknesses be even multiples of a carrier wavelength. This is because the wavelength of carriers traversing the superlattices and adjacent structures is a function of the applied energy. The carrier's energy, in turn, is a function of the voltage or bias applied across the device. Thus, for a device specifically designed to reflect a given energy E (superlattice is based on odd multiples), there inherently and necessarily exists some higher energy E' such that $\lambda_{E'} = 2\lambda_E$. Restated, when the thicknesses of the barriers and wells of this superlattice are designed so as to be odd multiples of the wavelength associated with energy, E , the thicknesses will be even multiples of this other energy E' .

The Examiner notes that a recitation of the intended use of the claimed invention must result in a structural difference between the claimed invention and the prior art in order to patentably distinguish the claimed invention from the prior art. If the prior art structure is capable of performing the intended use, then it meets the claim. See, e.g., *In re Pearson*, 181 USPQ 641 (CCPA); *In re Minks*, 169 USPQ 120 (Bd Appeals); *In re Casey*, 152 USPQ 235 (CCPA 1967);

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In re Otto, 136 USPQ 458, 459 (CCPA 1963). The language of this claim, as presented, does not distinguish the present invention over the combination of Tsuji and Takagi which possesses the same structure, as claimed.

c. Regarding claims 10 and 11, Tsuji discloses that the non-superlattice well (or carrier accumulation) layer where avalanche ionization takes place is designed to be very thin (e.g., col. 3, lines 52-56) but does not specifically disclose that the thickness is equal to the wavelength of the carriers. Nonetheless, it was well known that decreasing the thickness of the avalanche photodetector will increase the carrier transit time, thereby improving the device's performance, so these well layers should be made as thin as possible. Further, the avalanche photodetector of Tsuji operates by the electrons gaining energy from falling into the well to produce an avalanche multiplication effect. Basic quantum physics principles dictates that in order for an electron to exist in a very thin quantum well the boundary conditions for the wave function must be satisfied such that the well thickness is a half wavelength of the carrier energy or a multiple thereof (e.g., particle in a box model). Restated, it would have been obvious to one of ordinary skill in the art at the time of the invention to form the well thickness to be equal to $n\lambda/2$ where n = an integer for the purpose of improving the device's operation. It would have been further obvious to specifically set the well thickness based on $n = 1$ (i.e. the thickness being $\lambda/2$) for the purpose of allowing the electron entering the well to reach the lowest possible energy level to further maximize the device's operation. In such a design configuration where the carrier accumulation layer is set to a thickness $d = \lambda_E/2$ for a carrier energy E , the region would

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simultaneously inherently satisfy the equation $d = \lambda_E$ for the situation where a bias produces carriers having E' where $\lambda_{E'} = 2\lambda_E$, as was explained above.

16 b.w.B
5. Claims 13-~~15~~ are rejected under 35 U.S.C. 103(a) as being unpatentable over Tsuji/Takagi as applied to the claims above, and further in view of Motoda et al. '350. Tsuji/Takagi teaches all of the limitations of the claims as explained above except for the further inclusion of delta layers at the interface of the superlattices' barriers and wells. Motoda teaches that delta layers may be employed at the interfaces of a superlattice's barriers and wells for the purpose of more sharply varying the energy band profile at this interface. Thus, it would have been obvious to one of ordinary skill in the art at the time of the invention to employ delta layers in the superlattice regions taught by Tsuji/Takagi for the purpose of more sharply varying the energy band profile, as taught by Motoda thereby further improving the desired reflection/transmission characteristic for which the superlattice is designed.


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INFORMATION ON HOW TO CONTACT THE USPTO

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to the examiner, **B. William Baumeister**, at **(703) 306-9165**. The examiner can normally be reached Monday through Friday, 8:30 a.m. to 5:00 p.m. If the Examiner is not available, the Examiner's supervisor, Mr. Eddie Lee, can be reached at (703) 308-1690. Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0956.

B. William Baumeister

September 30, 2001



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